RECENT SPECIES OF THE GENUS *PETRICOLA* IN THE EASTERN PACIFIC [BIVALVIA: VENEROIDEA]

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In the course of preparing a volume on the bivalves of the northeastern Pacific, my attention was drawn to some nomenclatural problems involving the bivalve genus *Petricola*. The eventual result was an effort to stabilize their species-level taxonomy.

The taxonomic units at the generic level in the Petricolidae and, indeed, at the family level within the Veneroidea, are much in need of modern treatment. While I did not endeavor to prepare a cladistic analysis of the family or superfamily, I attempted to lay a stable foundation for such studies by reviewing previous work on the morphology and biology of species in the *Petricola* complex and providing a brief analysis of the nomenclature of relevant genera.

There are more petricolas in the eastern Pacific than anywhere else in the world, and they proved difficult to understand. Table 1 is a listing of the eastern Pacific and western Atlantic petricolid species. Unlike *Petricola carditoides*, one of the most common marine bivalves on the West Coast, many other taxa are rare, making it difficult to understand the limits of their variability. There is also a high proportion of missing type material, compounded by early, cryptic, unillustrated descriptions. However, I was able to locate type material for most of the species-level taxa, and 15 lectotype designations will be made in my formal paper.

There is a considerable literature on the anatomy, functional morphology, and behavior of some members of the Petricolidae, beginning with observations by Deshayes and Philippi in the 1830s and 40s on the Mediterranean *Petricola lithophaga* and Gould on the American *Petricolaria pholadiformis*. Fischer added anatomical information about the eastern Pacific *Petricola denticulata* and the Caribbean and Pacific *Choristodon robustum* in the late 1850s.

A thin scattering of additional information appeared over the next 100 years, until Purchon's major study on *Petricolaria pholadiformis* and Yonge's discussion of the eastern Pacific *Petricola carditoides*. Narchi described the functional morphology of *Choristodon robustum* and of his new *Petricolaria stellae*, and Morton reviewed the functional morphology of *Claudiconcha japonica*, a nestler in which the margin of the right valve curls around and partly encloses the left. Nielsen discussed *Petricola lapicida*, type species of the genus *Petricola*, and provided evidence that burrowing might be aided by chemical action. Morton discussed the anatomy of the eastern Pacific *Cooperella subdiaphana* and synonymized the Cooperellidae with the Petricolidae. (The two species of *Cooperella* are listed below but not further discussed.)

The basic family-level characters of the Petricolidae are three cardinal teeth in the left valve and two in the right, as opposed to the Veneridae, which has three teeth in each and sometimes laterals as well. However, it is possible that the loss of a cardinal tooth in the right valve has occurred independently at least twice in taxa that have been allocated to the Petricolidae, making it an artificial group. I am fairly certain that the species I am treating, which additionally have radial sculpture and a nestling or boring habitat, probably belong within the same clade.

Within our taxa, many species have a characteristic shape. For example, species of *Petricolaria*, which penetrate soft substrata are always elongate, whereas *Choristodon robustum*, which nestles in cavities in hard calcareous substrata, is always ovate. However, other species, can vary enormously in shape. External sculpture is very useful and often diagnostic. Radial sculpture predominates, but commarginal elements may also be present.

The shape of the pallial sinus is an important character in petricolids, particularly its depth, the extent to which it is horizontal or is dorsally directed, and whether it is rounded or pointed anteriorly. The pallial line may be coincident or entirely separate from the pallial sinus and may be bowed dorsally anterior to the sinus.

Nearly all the species treated have two cardinal

teeth in the right valve and three in the left, but the left anterior cardinal may be absent in the adult, or in one species it may be lacking entirely at all sizes. The hinge and teeth differ in their size and robustness, and in such details as which are bifid. The extent to which the external ligament is sunken below the hinge margin is also important. Although most species are drab, being white or tinged with brown, color pattern can provide important clues, and one species is bright red internally.

At present, I see no clear basis for separating the genus *Petricola* from the subsequently named genus *Pseudoirus*, which was established for a Japanese species, chiefly on the basis that it does not occur in coral. Members of *Petricola, s.s.* have fine, divaricate, sometimes zig-zag sculpture, an ovate shape, and a well-sunken ligament.

Eastern Pacific species include the very rare *Petricola botula* Olsson, 1961, known from only five lots, which occurs from Mazatlán, Sinaloa, Mexico, to Panamá, boring into rock or clay.

Petricola carditoides (Conrad, 1837) (Figures 1, 2) is the most common Californian species, and it has eight synonyms because of its variable shape [*californica* Conrad, *legumen*, *arcuata*, *cylindracea* and *mirabilis* Deshayes, *gibba* Middendorff and *abrupta* and *pedroana* Conrad]. A difficult nomenclatural problem concerns *mirabilis* Deshayes, which, although described from California, was attributed to Japan by Lischke, and subsequent workers did not question this. However, its holotype is a specimen of *P. carditoides*. In the meanwhile, the distinct Japanese species being called *mirabilis* was made the type species of the genus *Pseudoirus*. The common Californian species [516 lots] occurs from southeast Alaska to southern Baja California, nestling in rocky areas. It is known from deposits as old as the Pliocene, but Miocene records are probably in error.

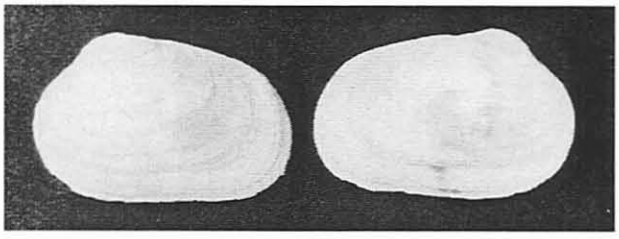

Figure 1. *Petricola (Petricola) carditoides* (Conrad, 1837). Holotype of *P. mirabilis* Deshayes, 1853. Monterey, California. Length: 35.9 mm.

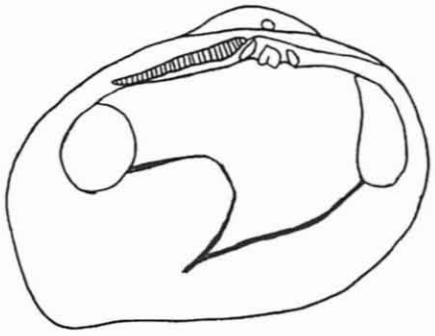

Figure 2. *Petricola (Petricola) carditoides*. CAS 102524. Monterey, California. Left valve. Length: 32.7 mm.

Petricola (Petricola) linguafelis Carpenter, 1857, (Figure 3) with two synonyms [*scobina* Conrad and *noemi* de Folin], never exceeds about 7 mm. It occurs from Baja California Sur and Sinaloa, México, to Ecuador. It is known from 23 lots. It has a very distinctive beaded sculpture that sets it apart from the young of related taxa. Its affinities seem to be with *Petricola, s.s.*, of which it may be a pedogenic derivative. I have examined a valve from the Bahamas that is similar and may be an undescribed homologue.

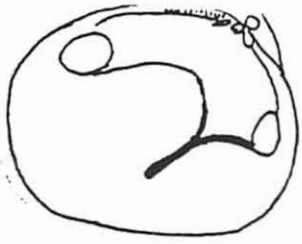

Figure 3. *Petricola (Petricola) linguafelis* Carpenter, 1857. LACM 70-9. Salinas, Guayas Province, Ecuador. Left valve. Length: 4.2 mm.

Petricola (Petricola) lucasana Hertlein & Strong, 1948, (Figure 4) occurs from Puerto Peñasco, at the head of the Golfo de California to Ecuador. The unique type of the synonymous *Petricola charapota* Olsson, 1961, from Ecuador has its beaks very close to the anterior end, whereas in the Golfo de California, *lucasana* tends to assume an oval outline, sometimes becoming higher than long. However, there is a scattering of material that bridges this morphological gap. I've examined 73 lots.

Several species are tentatively placed in the subgenus *Petricolirus*, based on the Japanese *Petricola aequistriata* G. B. Sowerby II, 1874. Members of this subgenus have an elongate shape and radial sculpture

that is generally more conspicuous than that in *Petricola, s.s.* and that is neither divaricate nor zig-zag, and the ligament is not sunken.

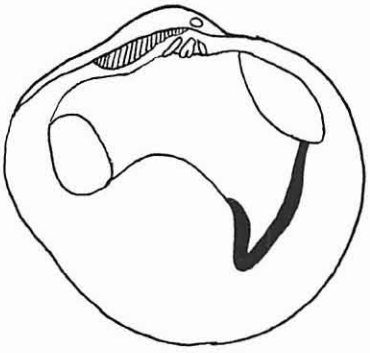

Figure 4. *Petricola (Petricola) lucasana* Hertlein & Strong, 1948. CAS 102518. Puerto Peñasco, Sonora, México. Left valve. Length: 22.3 mm.

Petricola (Petricolirus) californiensis Pilsbry & Lowe, 1932, (Figures 5, 6) occurs from Santa Barbara County, California, to Baja California Sur, and is recognized for the first time from the Golfo de California to Oaxaca, nestling in a variety of substrata, including teredinid burrows in driftwood, where it becomes extremely elongate. *Petricola pectarosa* (Conrad, 1834) from the Pliocene and Pleistocene of eastern North America may be its ancestor. I have seen 251 lots.

Petricola (Petricolirus) concinna G. B. Sowerby I, 1834, (Figures 7, 8) is a rare Ecuadorian species, occurring from Esmeraldas to La Libertad and in the Galápagos. I have found only 8 lots.

Petricola (Petricolirus) dactylus G. B. Sowerby I, 1823, (Figure 9) is a previously unrecognized senior synonym of *Petricola patagonica* d'Orbigny, 1845. It occurs from Uruguay to southern Chile. The name *P. dactylus* was misapplied to specimens of *Petricolaria pholadiformis* from the northwestern Atlantic. As a consequence, its proper place as a senior synonym of *P. patagonica*, confirmed here by the discovery of its holotype, has been overlooked. *Petricola chiloensis* Philippi is a probable synonym. I have seen 32 lots.

The common Panamic *Petricola (Petricolirus) denticulata* G. B. Sowerby I, 1834, (Figures 10,11) has three synonyms [*denticulata abbreviata* Sowerby, *peruviana* Jay, and *ventricosa* Deshayes] and occurs from Baja California to Perú. It is relatively common, and I've studied 181 lots.

The South America *Petricola (Petricolirus) rugosa*

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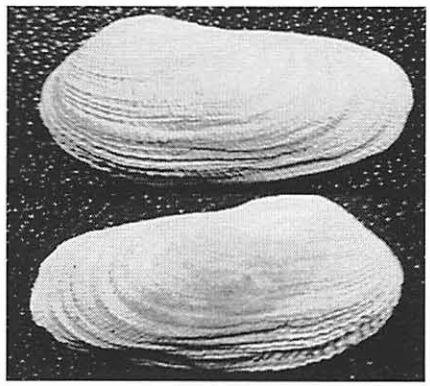

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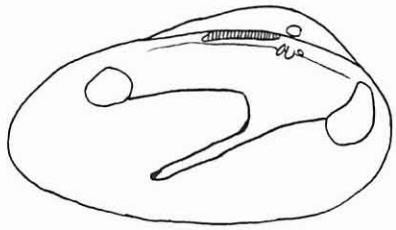

Figures 5, 6. *Petricola (Petricolirus) californiensis* Pilsbry & Lowe, 1932. (5) Holotype, ANSP 114337. San Pedro, California. Length: 26.5 mm. (6) Socorro, Baja California, México. Left valve. Length: 28.3 mm.

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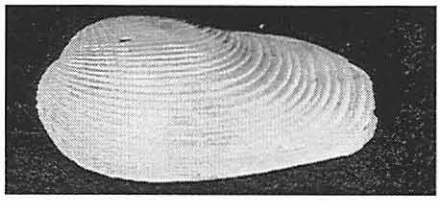

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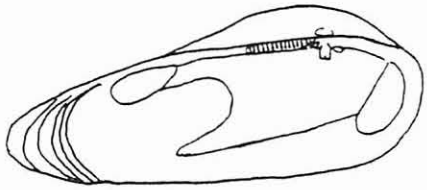

Figures 7, 8. *Petricola (Petricolirus) concinna* G. B. Sowerby I, 1834. (7) Syntype BM(NH) 19665. Montecristi [Manta], Ecuador. Length: 21.1 mm. (8) LACM 71.50.1. Bahía Bartolomé, Isla Bartolomé, Islas Galápagos. Left valve. Length: 20.3 mm.

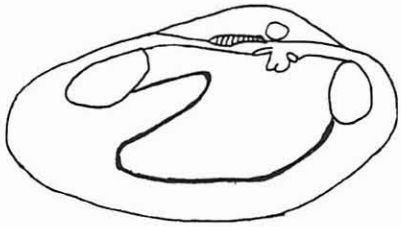

Figure 9. *Petricola (Petricolirus) dactylus* G. B. Sowerby I, 1823. SBMNH 133419. Punta Arenas, Magallanes Province, Chile. Left valve. Length: 25.6 mm.

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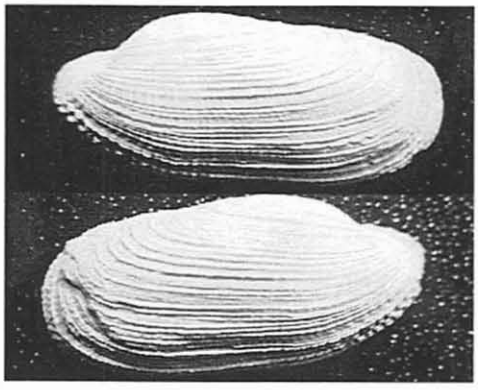

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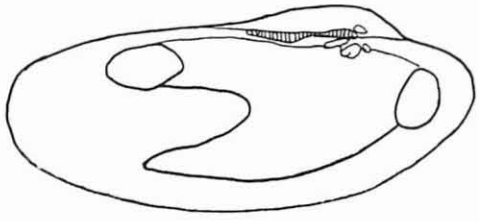

Figures 10, 11. *Petricola (Petricolirus) denticulata* G. B. Sowerby I, 1834. (10) Lectotype of *Venerupis peruviana* Jay, 1839. AMNH 56118. Perú. Length: 27.2 mm. (11) CAS 024296. Canoa, Manabí Province, Ecuador. Left valve. Length: 33.5 mm.

G. B. Sowerby I, 1834 (Figure 12), with five confirmed or probable synonyms [*tenuis* Sowerby, *costata* and *rhyssodes* Philippi, *ovata* Troschel, and *calderensis* Conrad], occurs from Perú to Chile. It is highly variable in shape and sculpture, with some specimens being almost cylindrical and others flattened and expanded. The sculpture varies from subdued to heavy. I have examined 37 Recent lots.

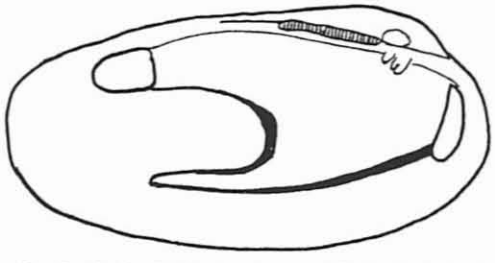

Figure 12. *Petricola (Petricolirus) rugosa* G. B. Sowerby I, 1834. ANSP 323775. Lurin, Lima Province, Perú. Left valve. Length: 33.5 mm.

One is left with several species that cannot be assigned to named subgenera. These include *Petricola exarata* (Carpenter, 1857) (Figure 13), which occurs from central Mexico to northern Peru, nesting in

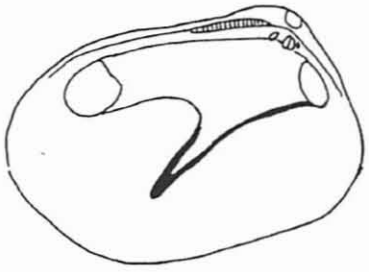

Figure 13. *Petricola exarata* (Carpenter, 1857). CAS 102591. Altata, Sinaloa, México. Left valve. Length: 13.5 mm.

crevices in rocky areas near mangrove swamps. It is represented by 34 lots.

Petricola "A" is a new species (Figures 14, 15) that occurs from southern California to Bahía Magdalena, Baja California Sur, where it occurs in association with algae. This species, rarely attaining more than 8 mm, was previously known as *Petricola tellimyalis* (Carpenter, 1864). However, the tiny holotype of *tellimyalis* is not a *Petricola*, but rather a previously unrecognized synonym of the bernardinid *Halodakra subtrigona*, leaving the small *Petricola* nameless. It is represented in collections by 55 lots.

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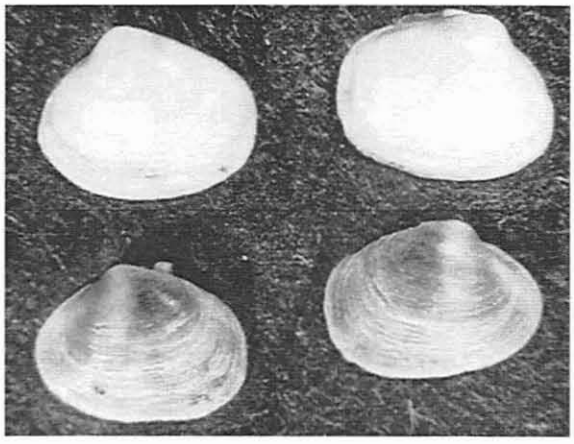

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Figures 14, 15. *Petricola* sp." A." (14) two potential paratypes. San Pedro, California. Length: ~5.3 mm. (15) Left valve. Potential paratype, CAS 106035.

Petricola olssoni Bernard, 1983, (Figure 16) occurs from Perú to Chile, and 22 lots have been studied. It is a renamed homonym [*Petricola peruviana* Olsson, 1951, *non* (Jay, 1839)]

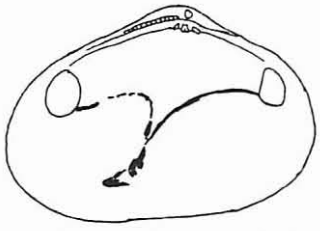

Figure 16. *Petricola olssoni* Bernard, 1983. ANSP 252061. Peninsula Paracas, Ica Province, Perú. Composite of two specimens; lengths: 12.3 & 15.0 mm.

Petricola "B" (Figure 17) is a second new species. It occurs from Panamá to Ecuador. As yet known from only 9 lots, it was figured but not discussed by Olsson (1961: pl. 55, fig. 11).

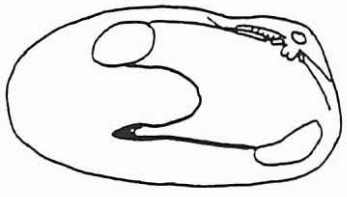

Figure 17. *Petricola* sp."B." Potential holotype. Left valve. Length: 16.9 mm.

I am recognizing *Choristodon* as a full genus characterized by a thick shell, heavy radial sculpture, a sunken ligament, and a hinge that becomes highly distorted in large specimens. *Choristodon robustum* (G. B. Sowerby I, 1834) (Figures 18, 19) has eight synonyms [*typicum* Jonas, *robusta* Philippi, *sinuosa* Conrad, *bulbosa* Gould, *anchoreta* and *venusta* de Folin, *buwaldi* Clark, and *riocanensis* Maury], and occurs from central Baja California to Perú, and in the western Atlantic from North Carolina to Brazil, in calcareous substrata, such as shells of *Spondylus* and colonial corals. I have studied 82 Recent eastern Pacific lots. It had long been recognized that the eastern Pacific *robustum* G. B. Sowerby I, 1834, is very similar to the Caribbean *typica* Jonas, 1844, type species of *Choristodon*. Woodring (1982) synonymized them, placing the senior *robustum* into the synonymy of the junior *typica*. There seem to be subtle differences between Caribbean and Pacific material, including maximum size, shape, and color, but I am leaving them in synonymy pending future, more detailed study by other workers. Woodring also placed *Petricola riocanensis* Maury, from the Miocene of Dominican Republic, into the synonymy here, and my examination of the type specimen of the Miocene *P. buwaldi* Clark from central California demonstrates that it is also within the range of variability of this species.

One additional Atlantic species has also been placed in *Choristodon, Choristodon cancellatus* Verrill, 1885, (Figure 20) described from off Chesapeake Bay in 70 fm [128 m]. This taxon was based on one worn left valve measuring 7.7 mm in length, 6.2 mm in height, and 3.0 mm in thickness [USNM 44839] (Verrill, 1885: 435-436).

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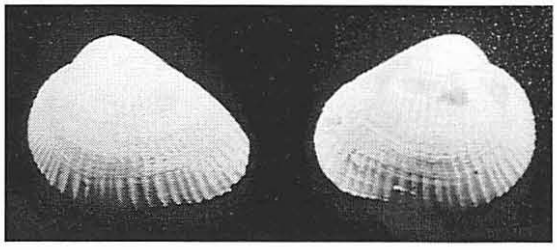

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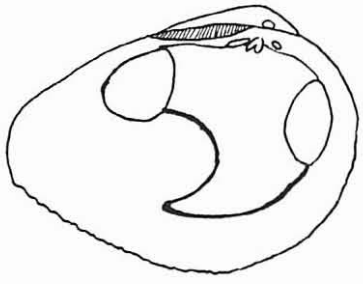

Figures 18, 19. *Choristodon robustum* (G. B. Sowerby I, 1834). (18) Holotype, *Petricola bulbosa* Gould, 1851. MCZ 169065. Guaymas, Sonora, México. Length: 27.8 mm. (19) SBMNH 143212. Bahía San Carlos, Sonora, México. Left valve. Length: 21.8 mm.

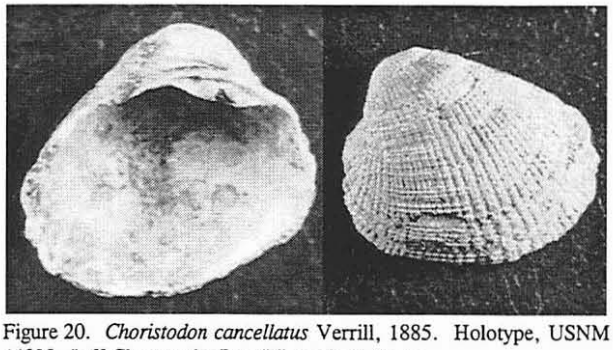

Figure 20. *Choristodon cancellatus* Verrill, 1885. Holotype, USNM 44839. "off Chesapeake Bay." Length: 7.7 mm.

This unique holotype is not a petricolid, but I am not certain what it is. It is possible that it is from an offshore fossil locality.

Petricolaria is also tentatively afforded generic status, and is represented in the eastern Pacific by two species, one native and one introduced.

The native species is *Petricolaria cognata* (C. B. Adams, 1852) (Figures 21, 22). This is the oldest name for what has mostly gone under the name *parallela* Pilsbry & Lowe. It occurs from Baja California to Ecuador, in soft substrata, such as clay banks. The holotype of *P. cognata* is a short, thick, but not highly unusual specimen. I have studied 91 lots. There is a group of tropical species of *Petricolaria* that account for mistaken records of the Northern Hemisphere *Petricolaria pholadiformis* in the Southern Hemisphere. These include *P. gracilis* (Deshayes, 1853), which occurs in the Indian Ocean and the Red Sea, *Petricolaria stellae* Narchi, 1975, occurring from Brazil to Uruguay, and *Petricolaria serrata* (Deshayes, 1853), described from an unknown locality. The relationships among these three taxa have yet to be resolved.

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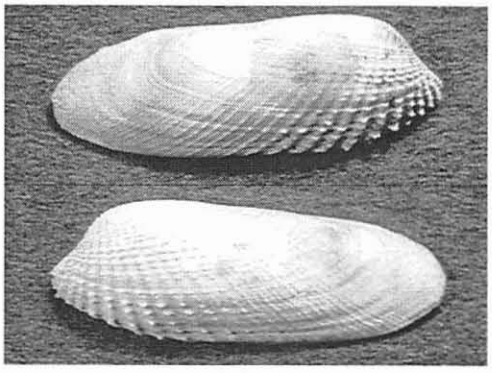

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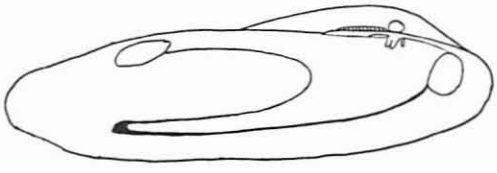

Figures 21, 22. *Petricola cognata* (C.B. Adams, 1852). (21) Holotype of *Petricola gracilis parallela* Pilsbry & Lowe, 1932. ANSP 155591. Corinto, Nicaragua. Length: 28.7 mm. (22) SBMNH 143213. Cochore, Guaymas, Sonora, México. Left valve. Length: 43.7 mm.

Petricolaria pholadiformis (Lamarck, 1818) (Figures 23, 24) was introduced on the West Coast, and now survives in low numbers in two bays. It has six synonyms [*fornicata* and *flagellata* Say, *carolinensis* Conrad, *tumida* Verrill, *pholadiformis lata* Dall, and *rogersi* McGavock]. It came with oysters in three localities in the northeastern Pacific: Willapa Bay, Washington, and San Francisco and Newport bays, California, but it did not survive in Newport Bay, and it does not seem to have spread beyond Willapa and San Francisco bays, where it burrows in clay. In its native habitat in the western Atlantic, it occurs from Canada to the Golfo de México. It was also introduced into the eastern Atlantic, and it now thrives from Norway to the Black Sea. I have examined 32 eastern Pacific lots.

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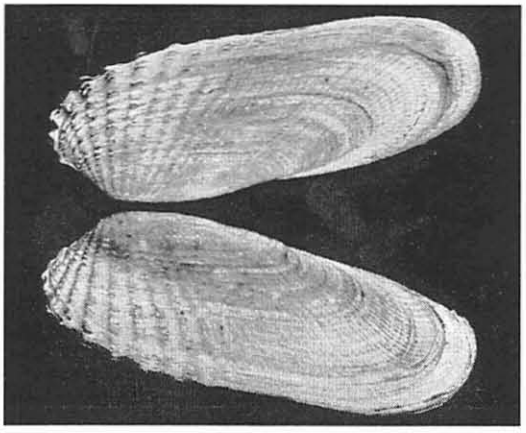

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Figures 23, 24. *Petricolaria pholadiformis* (Lamarck, 1818). (23) Holotype 1082/97, Museum d'Histoire Naturelle, Geneva. Length: 46.0 mm. (24) CAS 012508. Woods Hole, Barnstable Co., Massachusetts. Left valve. Length: 39.8 mm.

I have been able to exclude a number of taxa that are either non-petricolids or are *nomina dubia*. One of these is *Ungulina luticola* Valenciennes, 1846, which was described on the basis of four specimens now in the Paris Museum and long regarded as a synonym of *Petricola carditoides*. However, the originally figured specimen is instead *Thracia curta* Conrad, 1837, and the type lot includes specimens of *Petricola*, *Sphenia*, and *Thracia*, members of three different orders of bivalves.

In my formal paper, now under review, I discuss the fossil occurrences of these taxa, give full citations for all of the taxa discussed, and provide a run-down on related generic units in the family and their characters. In several cases, the type species of the genera and their methods of designation have been confused in previous literature.

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Table I. List of Eastern Pacific and Western Atlantic Petricolidae

EASTERN PACIFIC	WESTERN ATLANTIC
Petricola (Petricola) botula Olsson, 1961	
Petricola (Petricola) carditoides (Conrad, 1837)	
Petricola (Petricola) linguafelis Carpenter, 1857	
Petricola (Petricola) lucasana Herlein & Strong, 1948	
Petricola (Petricolirus) californiensis Pilsbry & Lowe, 1932	
Petricola (Petricolirus) concinna G. B. Sowerby I, 1834	
Petricola (Petricolirus) dactylus G. B. Sowerby I, 1823	
Petricola (Petricolirus) denticulata G. B. Sowerby I, 1834	
Petricola (Petricolirus) rugosa G. B. Sowerby I, 1834	
Petricola "A"	
Petricola "B"	
Petricola exarata (Carpenter, 1857)	
Petricola olssoni Bernard, 1983	
Choristodon robustum (G. B. Sowerby I, 1834)	*Choristodon robustum* (G. B. Sowerby I, 1834)
Petricolaria cognata (C. B. Adams, 1852)	
Petricolaria pholadiformis (Lamarck, 1818)	*Petricolaria pholadiformis* (Lamarck, 1818)
Cooperella subdiaphana (Carpenter, 1864)	*Cooperella atlantica* Rehder, 1943
	Petricola (Petricola) lapicida (Gmelin, 1791)
	Petricola (Petricolirus) dactylus G. B. Sowerby I, 1823
	Petricolaria stellae Narchi, 1975

THE FESTIVUS ANNOUNCES A SUPPLEMENT TO VOLUME XXVIII

The Festivus is proud to announce the publication of a supplement to Volume XXVIII. The monograph, by Hugh Bradner and E. Alison Kay, entitled **An Atlas of Cowrie Radulae (Mollusca: Gastropoda): Cypraeoidea: Cypraeidae)** will be available to 1996 members/subscribers who wish to receive it, at no cost.

The monograph of 176 pages + index treats over 202 species in 13 patterns and is profusely illustrated with the radulae being shown in both SEM and optical photographs.

For non-members/subscribers, the supplement will be available for sale. The prices, including postage, are as follows: $25 (domestic), $28 (overseas surface mail), $32 (overseas air mail).

Members who wish to receive the supplement must check off the appropriate box on the member renewal pink slip enclosed with this issue.

The Bradner/Kay supplement will be available for mailing in January.